EXHIBIT B

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Lacroix et al.

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(54) **HAPTIC FEEDBACK SYSTEM WITH STORED EFFECTS**

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(51) **Int. Cl.**
G06F 3/041 (2006.01)
G09G 5/00 (2006.01)

(52) **U.S. Cl.**
USPC **345/173**; 345/156; 715/701

(58) **Field of Classification Search**
USPC 345/156–173; 710/1, 5, 8, 58; 715/700–702
See application file for complete search history.

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(57) **ABSTRACT**

A haptic feedback system that includes a controller, a memory coupled to the controller, an actuator drive circuit coupled to the controller, and an actuator coupled to the actuator drive circuit. The memory stores at least one haptic effect that is executed by the controller in order to create a haptic effect.

15 Claims, 6 Drawing Sheets

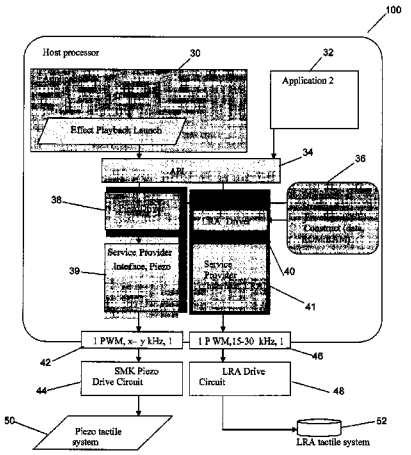

TABLE 3-continued

Generalized Voltage/Time Pair Encoding, "Set & Ramp" Pair:

Byte #	Bits	Data	Meaning
1	7 . . . 0	Time, ms/5	Time, in 5 ms increments. For best results, the driver code should run the control loop at 200 Hz. Maximum time that can be encoded = 255 × 5 ms = 1.275 sec. For longer durations, create a sequence of voltage/time pairs.
2	7 . . . 0	Slope	−128, or −127 to 127. Whole part of the slope value, representing whole PWM steps to be taken every 5 ms. −128 represents a Slope of "negative 0", versus "positive 0", which is 0. More on slope below.
3	7 . . . 0	SlopeFrac	0 . . . 255. Fractional part of the slope value, expressed as a fraction of 256. More on slope below.

Using Slope and SlopeFrac

The driver can use these values in the following way:

pwm=Voltage<<1; /* Initial PWM value */
pwm_rem=0; /* Initial PWM remainder */
In 5 ms loop:

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If( (pwm_rem + SlopeFrac) < pwm_rem ) /* this remainder is about to rollover */
{
Slope >= 0 ? pwm++ : pwm--;
}
pwm_rem += SlopeFrac;
if( −128 != Slope) pwm += Slope;
```

The Effect Name Block, which is optional, has one sub-block: an Effect Name Data Sub-Block.

Several embodiments are specifically illustrated and/or described herein. However, it will be appreciated that modifications and variations of are covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

What is claimed is:

1. A haptic feedback system comprising:
a processor;
a memory coupled to the processor, wherein the memory stores a plurality of pre-defined haptic effects;
an actuator drive circuit coupled to the processor; and
an actuator coupled to the actuator drive circuit;
wherein the processor is adapted to output a first stored haptic effect of the pre-defined haptic effects in response to a haptic effect request;
wherein the haptic effect request is a control signal generated in response to a first application that identifies the first stored haptic effect to be played;
wherein the output causes the first stored haptic effect to be played;
wherein the entire haptic output in response to the haptic effect request consists of the first stored haptic effect;
wherein an application program interface (API) receives the haptic effect request from the first application and retrieves the requested first stored haptic effect, wherein the first application is registered with the API and a second application is also registered with the API and has access to the first stored haptic effect.

2. The haptic feedback system of claim **1**, wherein the haptic effect request comprises an identity of the pre-defined haptic effect to be outputted.

3. The haptic feedback system of claim **1**, wherein each of the plurality of pre-defined haptic effects are stored as a digitized streamed envelope construct.

4. The haptic feedback system of claim **1**, further comprising:
a second actuator drive circuit coupled to the processor; and
a second actuator coupled to the second actuator drive circuit;
wherein the second actuator is a different type of actuator than the actuator.

5. The haptic feedback system of claim **1**, wherein the haptic effect request comprises a priority, and the first stored haptic effect is outputted based on the priority.

6. The haptic feedback system of claim **1**, wherein the first stored haptic effect is outputted to the actuator drive circuit, and in response the actuator drive circuit generates a haptic feedback signal that is applied to the actuator to generate haptic feedback.

7. The haptic feedback system of claim **6**, wherein the haptic feedback signal is based only on one of the predefined haptic effects.

8. A method of generating haptic feedback comprising:
receiving a request for one of a plurality of pre-defined stored haptic effects, wherein the request is a control signal generated in response to a first application that identifies the haptic effect out of the plurality of haptic effects to be played;
retrieving the requested pre-defined stored haptic effect;
generating drive signals based on the retrieved pre-defined stored haptic effect; and
applying the drive signals to an actuator;
wherein the entire haptic output in response to the request consists of the requested pre-defined stored haptic effect;
wherein an application program interface (API) receives the haptic effect request from the first application and retrieves the requested pre-defined stored haptic effect, wherein the first application is registered with the API and a second application is also registered with the API and has access to the requested pre-defined stored haptic effect.

9. The method of claim **8**, wherein each of the plurality of pre-defined haptic effects are stored as a digitized streamed envelope construct.

10. The method of claim **8**, wherein the request comprises a priority, and the one of the pre-defined haptic effects is retrieved based on the priority.

11. The method of claim **8**, wherein the haptic feedback is generated from only the pre-defined stored haptic effects.

12. A non-transitory computer readable medium having instructions stored thereon that, when executed by a processor, causes the processor to generate haptic feedback, the instructions comprising:

receiving a request for one of a plurality of pre-defined stored haptic effects, wherein the request is a control signal generated in response to a first application that identifies the haptic effect out of the plurality of haptic effects to be played;

retrieving the requested pre-defined stored haptic effect;

generating drive signals based on the retrieved pre-defined stored haptic effect; and

applying the drive signals to an actuator;

wherein the entire haptic output in response to the request consists of the requested pre-defined stored haptic effect;

wherein an application program interface (API) receives the haptic effect request from the first application and retrieves the requested pre-defined stored haptic effect, wherein the first application is registered with the API and a second application is also registered with the API and has access to the requested pre-defined stored haptic effect.

13. The computer readable medium of claim **12**, wherein each of the plurality of pre-defined haptic effects are stored as a digitized streamed envelope construct.

14. The computer readable medium of claim **12**, wherein the request comprises a priority, and the one of the pre-defined haptic effects is retrieved based on the priority.

15. The computer readable medium of claim **12**, wherein the haptic feedback is generated from only the pre-defined stored haptic effects.

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